US010329929B2

(12) **United States Patent**
Oren et al.

(10) **Patent No.: US 10,329,929 B2**
(45) **Date of Patent: Jun. 25, 2019**

(54) **RETAINING RING AXIALLY LOADED AGAINST SEGMENTED DISC SURFACE**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 560 days.

(21) Appl. No.: **15/070,703**

(22) Filed: **Mar. 15, 2016**

(65) **Prior Publication Data**

US 2017/0268352 A1 Sep. 21, 2017

(51) **Int. Cl.**

F02C 3/04	(2006.01)
F01D 9/02	(2006.01)
F01D 5/02	(2006.01)
F01D 5/06	(2006.01)
F01D 5/08	(2006.01)
F01D 5/30	(2006.01)

(52) **U.S. Cl.**

CPC ***F01D 9/02*** (2013.01); ***F01D 5/02*** (2013.01); ***F01D 5/026*** (2013.01); ***F01D 5/066*** (2013.01); ***F01D 5/082*** (2013.01); ***F01D 5/3015*** (2013.01); ***F02C 3/04*** (2013.01); *F05D 2220/32* (2013.01); *F05D 2260/30* (2013.01)

(58) **Field of Classification Search**

CPC . F01D 5/02; F01D 5/026; F01D 5/066; F01D 5/082; F01D 5/3015; F01D 9/02; F02C 3/04; F05D 2220/32; F05D 2260/30

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,988,325 A * 6/1961 Dawson F01D 5/081 415/110
3,814,539 A * 6/1974 Klompas F01D 5/081 415/115

(Continued)

FOREIGN PATENT DOCUMENTS

EP 0 921 272 A2 6/1999
EP 2 146 051 A1 1/2010

OTHER PUBLICATIONS

Extended European Search Report for Application No. 17 16 1174.2-1610 dated Aug. 10, 2017 (9 pp.).

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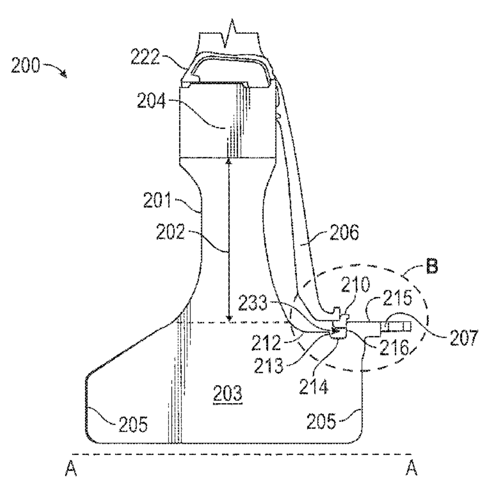
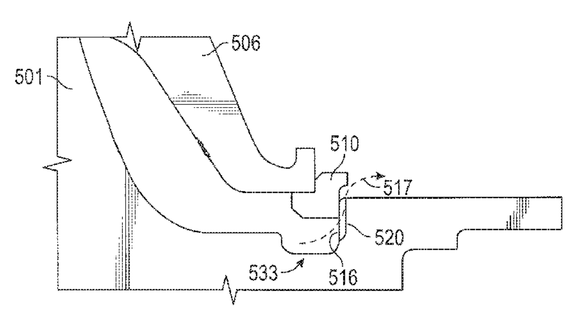
(57) **ABSTRACT**

A disc of a gas turbine engine system with particular retaining ring placement and engagement implementation are provided. For example, the disc includes a disc bore including, a groove formed on an axially extending surface of the disc bore, wherein the groove includes a forward surface that extends radially into the disc bore to a groove floor that is cut into the disc bore and extends axially to an aft surface that extends radially outward to at least the axially extending surface of the disc bore, and a scallop formed along at least one surface of the groove, wherein the scallop is configured to provide a flow path, and a disc web that extends radially outward from the disc bore, relative to an axis of rotation of the gas turbine engine.

20 Claims, 5 Drawing Sheets





(56) **References Cited**

U.S. PATENT DOCUMENTS

5,275,534	A *	1/1994	Cameron	F01D 11/006 416/220 R
5,288,210	A	2/1994	Albrecht et al.	
5,320,488	A *	6/1994	Meade	F01D 5/025 415/173.7
5,816,776	A *	10/1998	Chambon	F01D 5/066 415/174.5
6,106,234	A *	8/2000	Gabbitas	F01D 5/3015 416/220 R
7,040,866	B2 *	5/2006	Gagner	F01D 5/3015 416/220 R
8,840,375	B2 *	9/2014	Virkler	F01D 5/066 416/221
9,212,562	B2 *	12/2015	Burt	F01D 5/3015
10,024,183	B2 *	7/2018	Partyka	F01D 5/3015
10,100,652	B2 *	10/2018	Weise	F01D 11/02
2012/0027598	A1 *	2/2012	Caprario	F01D 5/082 416/193 R
2014/0086740	A1	3/2014	Arnold	
2015/0369061	A1 *	12/2015	Sandoval	F02C 3/04 60/805

* cited by examiner

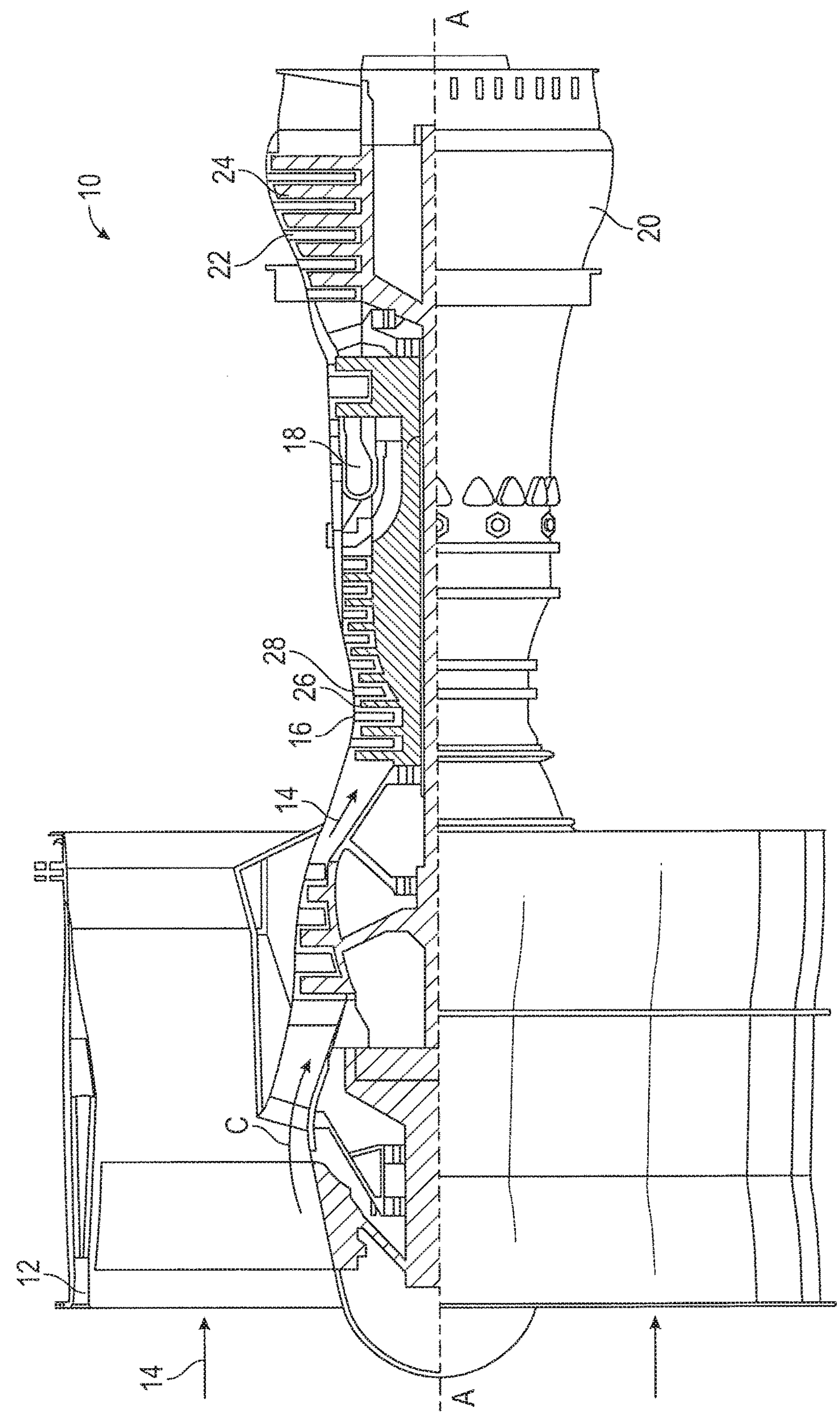
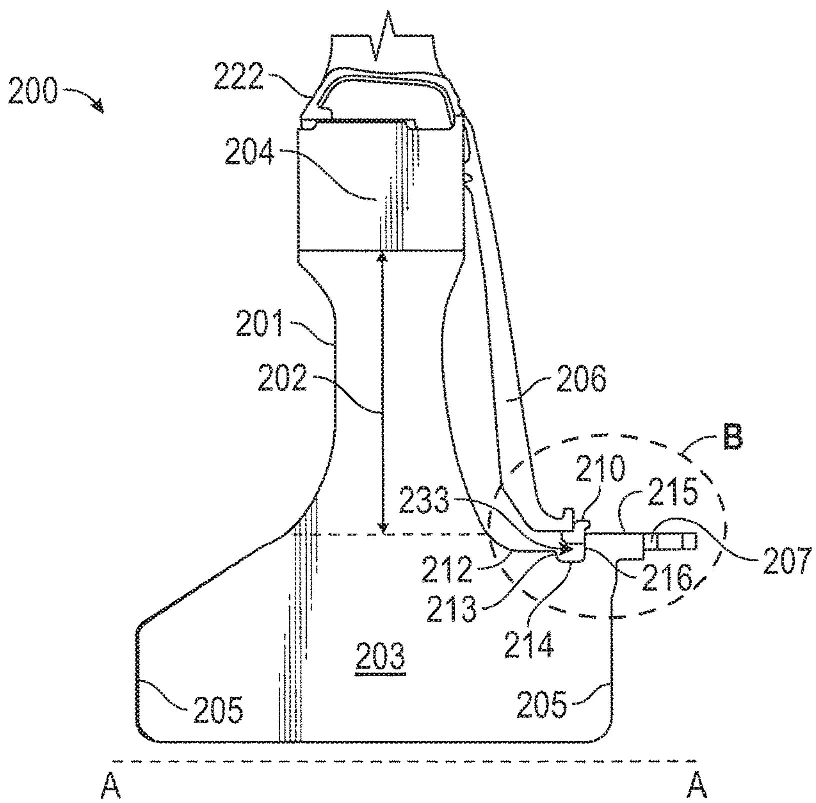


FIG. 1


200
222
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214
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205
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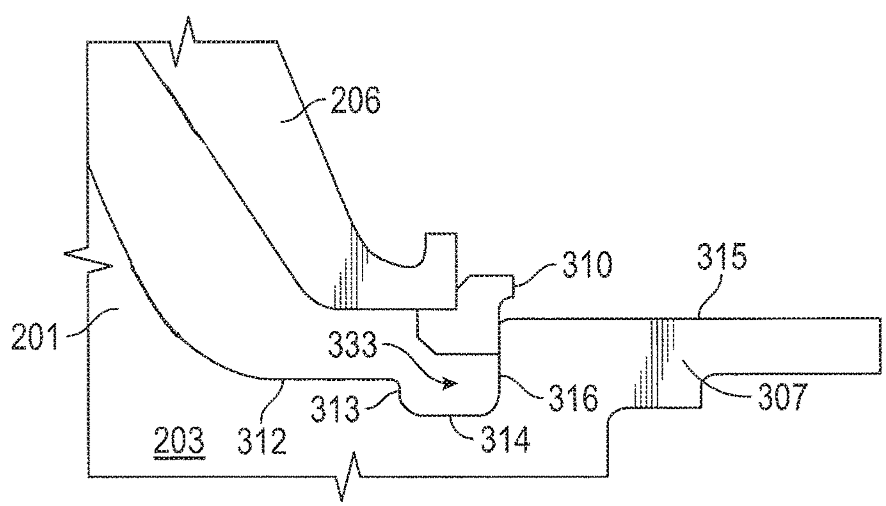
A

FIG. 2


206
310
315
201
333
316
307
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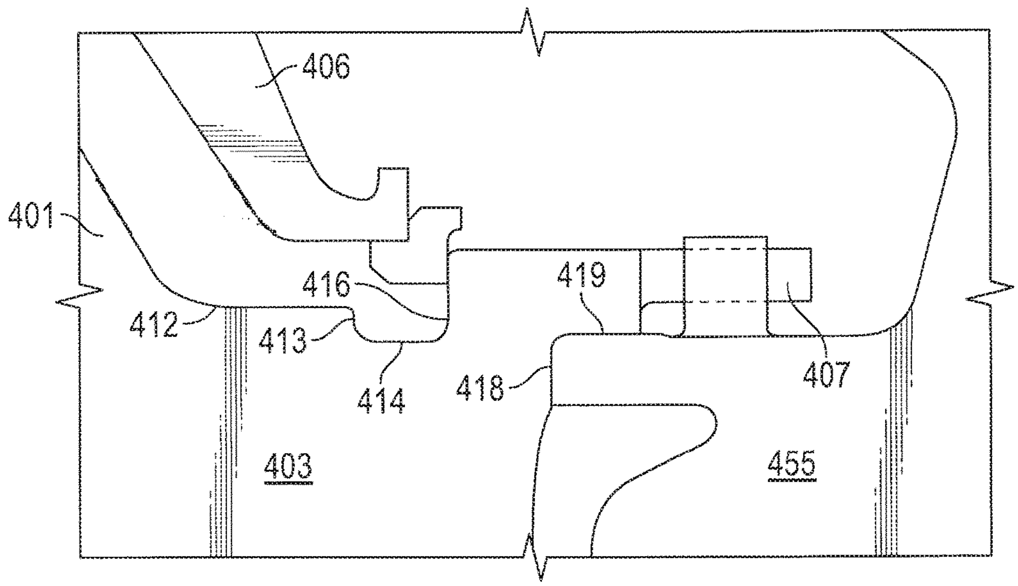
314

FIG. 3



406
401
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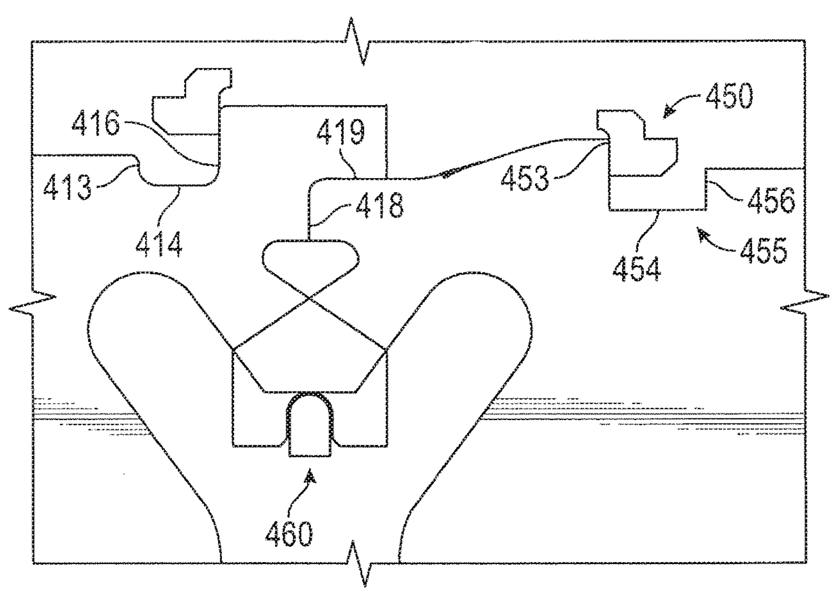
403
455

FIG. 4A



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418
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455
460

FIG. 4B

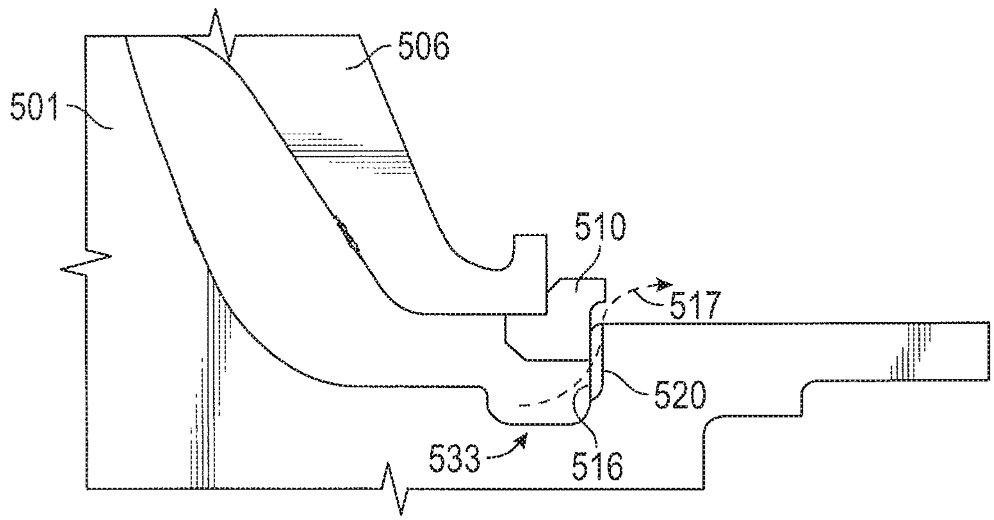


FIG. 5A

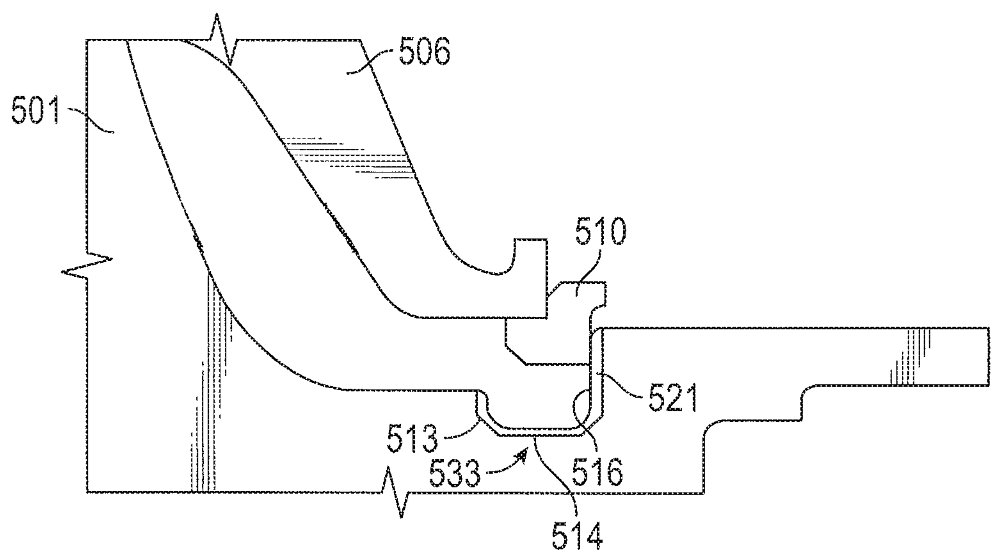
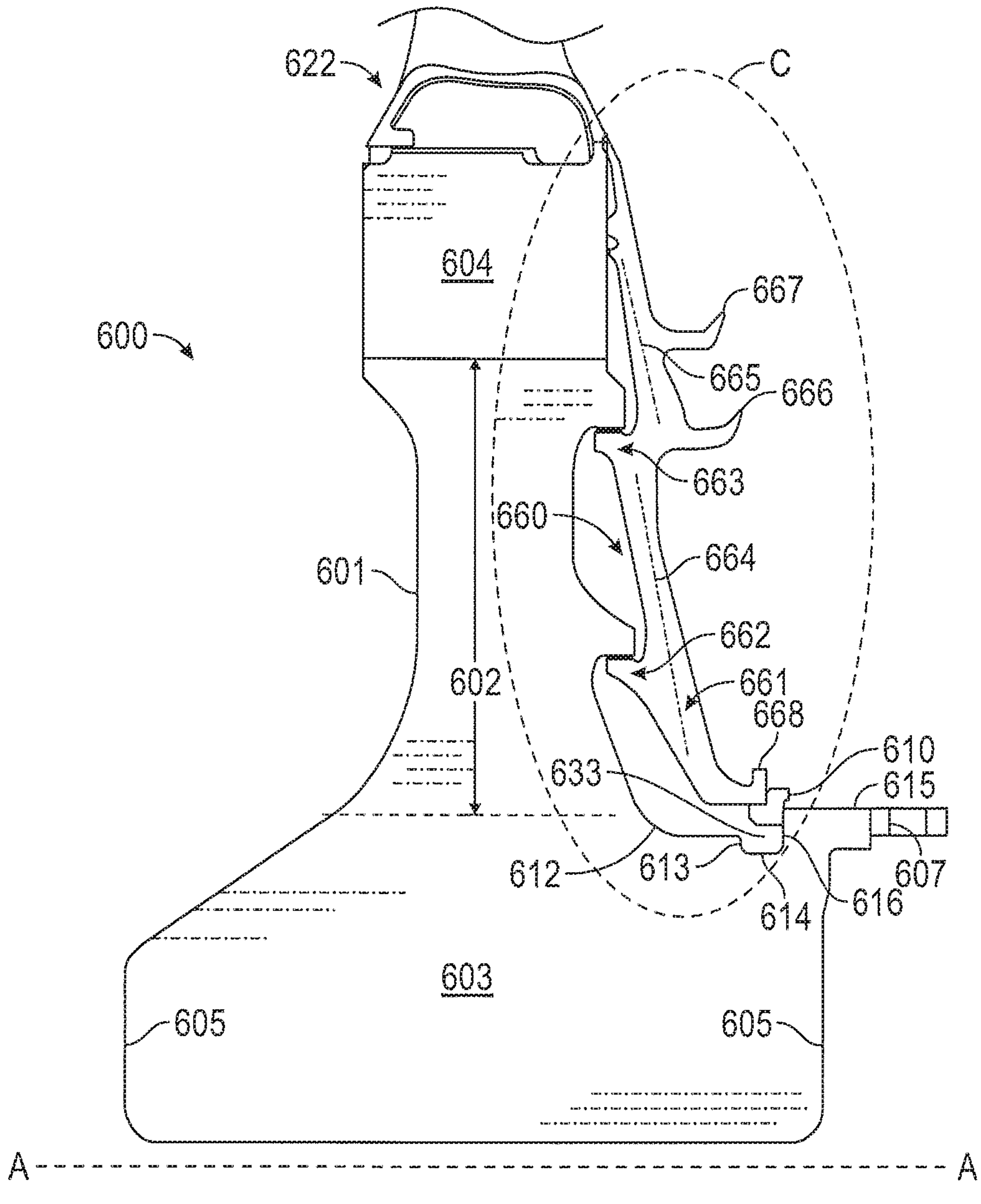


FIG. 5B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A
A

FIG. 6

RETAINING RING AXIALLY LOADED AGAINST SEGMENTED DISC SURFACE

BACKGROUND

The subject matter disclosed herein generally relates to attaching a disc and cover plate and, more particularly, to attaching a disc and cover plate with a retention ring.

Gas turbine engines, such as those used to power modern commercial and military aircrafts, generally include a compressor section to pressurize airflow, a combustor section for burning hydrocarbon fuel in the presence of the pressurized air, and a turbine section to extract energy from the resultant combustion gases. The airflow flows along a gas path between components through the gas turbine engine.

Accordingly, a gas turbine engine includes a plurality of rotating and static components arranged axially along an axis of rotation of the gas turbine engine, in both the compressor section and the turbine section. For example, the gas turbine engine includes a plurality of discs arranged in an axial direction that extend radially outward from the central axis of rotation. These discs also have coverplates that are coupled to the discs.

Accordingly there is a desire to find ways to connect the disc and cover plate.

SUMMARY

According to one embodiment a disc for a gas turbine engine is provided. The disc includes a disc bore including, a groove formed on an axially extending surface of the disc bore, wherein the groove includes a forward surface that extends radially into the disc bore to a groove floor that is cut into the disc bore and extends axially to an aft surface that extends radially outward to at least the axially extending surface of the disc bore, and a scallop formed along at least one surface of the groove, wherein the scallop is configured to provide a flow path, and a disc web that extends radially outward from the disc bore, relative to an axis of rotation of the gas turbine engine.

In addition to one or more of the features described above, or as an alternative, further embodiments of the disc may include wherein the disc bore further includes an interstage coupling disposed on the axially extending surface at a peripheral aft edge of the disc bore that includes a protrusion that extends axially in the aft direction beyond an aft surface of the disc bore.

In addition to one or more of the features described above, or as an alternative, further embodiments of the disc may include wherein the scallop is formed along the aft surface extending radially for a length of the aft surface forming the flow path.

In addition to one or more of the features described above, or as an alternative, further embodiments of the disc may include wherein the scallop is formed along the aft surface and the forward surface forming the flow path.

In addition to one or more of the features described above, or as an alternative, further embodiments of the disc may include further includes a disc blade attachment connected to the disc web at an end of the disc web opposite the disc bore, wherein the disc blade attachment extends radially outward, wherein the disk blade attachment in configured to attach an airfoil to an upper surface of the disc blade attachment, and a cover plate that extends from the disc blade attachment radially along an outside surface of the disc web toward the disc bore creating a cavity between the cover plate and disc web.

In addition to one or more of the features described above, or as an alternative, further embodiments of the disc may include a retaining ring configured to engage with the groove between the cover plate and disc, wherein the retaining ring connects to the interstage coupling of the disc bore and extends into the groove.

In addition to one or more of the features described above, or as an alternative, further embodiments of the disc may include wherein the groove includes a depth that extends radially into the disc bore, and wherein the retaining ring expands into the depth when a compressing force is applied between the cover plate and disc.

In addition to one or more of the features described above, or as an alternative, further embodiments of the disc may include wherein the interstage coupling is configured to couple the disc to a second adjacent disc.

In addition to one or more of the features described above, or as an alternative, further embodiments of the disc may include wherein the groove is located adjacent to the interstage coupling.

In addition to one or more of the features described above, or as an alternative, further embodiments of the disc may include wherein the cover plate and disc hold the retaining ring in place, and wherein the cover plate and disc hold positions relative to each other when connected using the retaining ring.

According to an embodiment, a rotor for a gas turbine engine is provided. The rotor includes at least one disc, the disc including a disc bore including, a groove formed on an axially extending surface of the disc bore, wherein the groove includes a forward surface that extends radially into the disc bore to a groove floor that is cut into the disc bore and extends axially to an aft surface that extends radially outward to at least the axially extending surface of the disc bore, a scallop formed along at least one surface of the groove, wherein the scallop is configured to provide a flow path, and an interstage coupling disposed on the axially extending surface at a peripheral aft edge of the disc bore that includes a protrusion that extends axially in the aft direction beyond an aft surface of the disc bore, and a disc web that extends radially outward from the disc bore, relative to an axis of rotation of the gas turbine engine, a disc blade attachment connected to the disc web at an end of the disc web opposite the disc bore, wherein the disc blade attachment extends radially outward, a cover plate that extends from the disc blade attachment radially along an outside surface of the disc web toward disc bore creating a cavity between the cover plate and disc web, a retaining ring configured to engage with the groove between the cover plate and disc, and an airfoil extending radially outward and connected to an upper surface of the disc blade attachment of the disc.

In addition to one or more of the features described above, or as an alternative, further embodiments of the rotor may include, wherein the scallop is formed along the aft surface extending radially for a length of the aft surface forming the flow path.

In addition to one or more of the features described above, or as an alternative, further embodiments of the rotor may include, wherein the scallop is formed along the aft surface and the forward surface forming the flow path.

In addition to one or more of the features described above, or as an alternative, further embodiments of the rotor may include a plurality of discs, a plurality of disc blade attachments, a plurality of cover plates, a plurality of retaining rings, and a plurality of airfoils.

In addition to one or more of the features described above, or as an alternative, further embodiments of the rotor may include, wherein the rotor is one selected from a group consisting of a compressor rotor, a combustor rotor, and a turbine rotor.

In addition to one or more of the features described above, or as an alternative, further embodiments of the rotor may include, wherein the retaining ring connects to the interstage coupling of the disc bore and extends into the groove.

In addition to one or more of the features described above, or as an alternative, further embodiments of the rotor may include, wherein the groove includes a depth that extends radially into the disc bore, and wherein the retaining ring expands into the depth when a compressing force is applied between the cover plate and disc.

In addition to one or more of the features described above, or as an alternative, further embodiments of the rotor may include, wherein the interstage coupling is configured to couple the disc to a second adjacent disc.

In addition to one or more of the features described above, or as an alternative, further embodiments of the rotor may include, wherein the groove is located adjacent to the interstage coupling.

According to an embodiment, a gas turbine engine is provided. The gas turbine engine includes a turbine section, a combustor section to provide combustion gases to the turbine section, and a compressor section to compress an airflow and direct the compressed airflow toward the combustor, and a rotor disposed in at least one of the turbine section, combustor section, and compressor section, the rotor including at least one disc, the disc including a disc bore including, a groove formed on an axially extending surface of the disc bore, wherein the groove includes a forward surface that extends radially into the disc bore to a groove floor that is cut into the disc bore and extends axially to an aft surface that extends radially outward to at least the axially extending surface of the disc bore, a scallop formed along at least one surface of the groove, wherein the scallop is configured to provide a flow path, and an interstage coupling disposed on the axially extending surface at a peripheral aft edge of the disc bore that includes a protrusion that extends axially in the aft direction beyond an aft surface of the disc bore, and a disc web that extends radially outward from the disc bore, relative to an axis of rotation of the gas turbine engine, a disc blade attachment connected to the disc web at an end of the disc web opposite the disc bore, wherein the disc blade attachment extends radially outward, a cover plate that extends from the disc blade attachment radially along an outside surface of the disc web toward disc bore creating a cavity between the cover plate and disc web, a retaining ring configured to engage with the groove between the cover plate and disc, and an airfoil extending radially outward and connected to an upper surface of the disc blade attachment of the disc.

The foregoing features and elements may be combined in various combinations without exclusivity, unless expressly indicated otherwise. These features and elements as well as the operation thereof will become more apparent in light of the following description and the accompanying drawings. It should be understood, however, that the following description and drawings are intended to be illustrative and explanatory in nature and non-limiting.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other features, and advantages of the present disclosure are apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

FIG. **1** illustrates a schematic cross-sectional view of a gas turbine engine in accordance with one or more embodiments of the present disclosure;

FIG. **2** illustrates a schematic cross-sectional view of a disc of a gas turbine engine that is connected to a cover plate in accordance with one or more embodiments of the present disclosure;

FIG. **3** illustrates a schematic cross-sectional view of area B of FIG. **2** including a portion of the disc and cover plate of a gas turbine engine beginning to engage and connect in accordance with one or more embodiments of the present disclosure;

FIG. **4**A illustrates a schematic cross-sectional view of a portion of a first disc and a second disc of a gas turbine engine connected using an interstage coupling in accordance with one or more embodiments of the present disclosure;

FIG. **4**B illustrates a schematic cross-sectional view of a portion of another first disc and a second disc of a gas turbine engine connected using another interstage coupling in accordance with one or more embodiments of the present disclosure;

FIG. **5**A illustrates a schematic cross-sectional view of a portion of a disc of a gas turbine engine that includes a scallop in accordance with one or more embodiments of the present disclosure;

FIG. **5**B illustrates a schematic cross-sectional view of a portion of a disc of a gas turbine engine that includes a scallop in accordance with one or more embodiments of the present disclosure; and

FIG. **6** illustrates a schematic cross-sectional view of a cover plate of a gas turbine engine that is connected to a disc in accordance with one or more embodiments of the present disclosure.

DETAILED DESCRIPTION

As shown and described herein, various features of the disclosure will be presented. Various embodiments may have the same or similar features and thus the same or similar features may be labeled with the same reference numeral, but preceded by a different first number indicating the figure to which the feature is shown. Thus, for example, element "a" that is shown in FIG. X may be labeled "Xa" and a similar feature in FIG. Z may be labeled "Za." Although similar reference numbers may be used in a generic sense, various embodiments will be described and various features may include changes, alterations, modifications, etc. as will be appreciated by those of skill in the art, whether explicitly described or otherwise would be appreciated by those of skill in the art.

In some instances a retaining ring is placed between a disc and cover plate at a point of contact along a web portion of the disc. Specifically, an appendage or protrusion extending axially in an aft direction from the web portion of the disc extends out and then curve radially outward to form a ring groove. These appendages/protrusions provide the point at which a retaining ring can be provided for coupling the disc to a cover plate. The protrusions may be provided extending anywhere along the web portion of the disc. For example, the protrusions, rings, and cover plate connection point can be provided in a mid-section of the web of the disc, at the top of the web portion, at a point in-between, lower along the web, or a combination of positions along the web.

However, such a groove forming protrusion extending from a side of the web portion of a disc occupies space that could otherwise be left open or occupied by another feature of a gas engine turbine. Further such a protrusion extending from the side of the web portion of the disc can provide for a more complex disc manufacturing process. Additionally, such a protrusion has restricted structural strength and integrity limited by the thin dimensions of the appendage/protrusion.

Embodiments described herein are directed to a retaining ring groove that is submerged into disc of a rotor. The rotor may be a compressor rotor or turbine rotor and may include a plurality of similar discs each having a similar groove. Further, the rotor is part of a gas turbine engine. Particularly, the groove is located on a surface of a disc bore portion or hub portion of the disc. The groove is configured for a retaining ring, for example, a Z ring and may therefore also be called a Z ring groove.

FIG. **1** is a schematic illustration of a gas turbine engine **10**. The gas turbine engine generally has a fan **12** through which ambient air is propelled in the direction of arrow **14**, a compressor **16** for pressurizing the air received from the fan **12** and a combustor **18** wherein the compressed air is mixed with fuel and ignited for generating combustion gases.

The gas turbine engine **10** further comprises a turbine section **20** for extracting energy from the combustion gases. Fuel is injected into the combustor **18** of the gas turbine engine **10** for mixing with the compressed air from the compressor **16** and ignition of the resultant mixture. The fan **12**, compressor **16**, combustor **18**, and turbine **20** are typically all concentric about a common central longitudinal axis of the gas turbine engine **10**. In some embodiments, the turbine **20** includes one or more turbine stators **22** and one or more turbine rotors **24**. Likewise, the compressor **16** includes one or more compressor rotors **26** and one or more compressor stators **28**. It is to be appreciated that while description below relates to turbine rotors **24**, one skilled in the art will readily appreciate that the present disclosure may be utilized with respect to compressors **16**.

As shown, a forward direction is defined as a direction going left, parallel to axis A, toward the fan section **12** found at a forward most position of the gas engine turbine. An aft direction is defined as a direction going to the right, parallel to axis A, back toward the back of the gas engine turbine toward. Particularly, the aft direction extends toward the turbine stators **22** which are in an aft most position. For example, as shown, the ambient air is propelled in the aft direction as shown by arrow **14** which points in the aft direction.

Further, components may be provided that extend either radially and/or axially with respect to axis A which is the axis that axially traverses through the center of the gas turbine engine. Particularly, as shown, the axis A traverses axially from a forward to an aft position of the gas turbine engine. Thus, a radial direction, or radially extending, is defined as extending in a direction substantially perpendicular to the axis A. Additionally, if the radial direction is extending toward the axis A that can be defined as radially extending inward, or inward radial expansion. It follows that when the radial direction extends away from the axis A that is defined as radially extending outward, or outward radial expansion. Further, an axial direction, or axially extending, is defined as extending is a direction substantially parallel to the axis A. Additionally, the axial direction may extend in a forward or aft direction.

FIG. **2** illustrates a schematic cross-sectional view of a disc apparatus **200** of a gas turbine engine that is connected to a cover plate **206** in accordance with one or more embodiments of the present disclosure. As shown, a disc **201** is provided which is part of a rotor that can be included within any of the rotors in a gas turbine engine as shown in FIG. **1**. The disc **201** includes at least three components, and may include various surface components. For example, in accordance with one or more embodiments and as shown in FIG. **2**, the disc **201** includes a disc web **202** forming a middle portion of the disc **201** radially extending between a disc bore **203** and a blade attachment **204**.

The disc blade attachment **204** which is attached to an outer diameter of the disc web **202** as shown. That is, the disc blade attachment **204** is connected to an outermost axially extending surface the disc web **202** and extends radially outward from the disc web **202**. An airfoil **222**, which may be for example a blade, connects and extends radially outward from the disc blade attachment. The disc bore **203** is the portion of the disc **201** that is nearest the rotational axis A of the gas turbine engine (e.g., as shown in FIG. **1**). As shown, the disc bore **203** is wider, in the axial direction, than both the disc web **202** and the disc blade attachment **204**. Accordingly, there are provided an axially extending surface **212** at the peripheral ends **205** of the disc bore **203** which the disc web's **202** sides curve and terminate into.

On an aft facing side of the disc **201**, a cover plate **206** may be configured and installed to extend from the disc blade attachment **204** to a portion of the disc bore **203**, as discussed below. The cover plate **206** may form an interference fit or other engagement with the disc blade attachment **204** at an outer diameter thereof and form a connection with a plate connector **233** of the disc **201**, as described below. Alternatively, a cover plate **206** may be configured and installed on a forward facing side of the disc **201** to extend from the disc blade attachment **204** to a portion of the disc bore **203**.

According to one or more embodiments, the disc also includes a retaining ring **210** that is configured to retain the cover plate **206** in place with respect to the disc **201** when engaged into a groove **214** of a plate connector **233**, which may also be called a groove **233**. In accordance with some embodiments, the retaining ring **210** can be a Z ring, as known in the art. For example, a Z ring is a retaining ring that is substantially z shaped in cross section. The retaining ring **210** is provided along the axially extending surface **212** where the groove **233** meets the interstage coupling **207**. As shown the cover plate **206** extends radially to cover the disc web **202**, or a portion thereof leaving the area along the disc web for other components or elements such as radial snaps discussed and shown below in FIG. **6**. Rather, the cover plate **206** engages the retaining ring **210** that engaged the plate connector **233**, or groove, on the disc bore **203**.

Specifically, looking within area B as shown in FIG. **2**, in accordance with one or more embodiments, the interstage coupling **207**, which is part of and extends from the disc bore **203**, includes a forward facing side **216**. The interstage coupling **207** also includes a protrusion extending from the forward edge **216** in the aft direction a length of an axially extending surface **215** and is configured to connect the disc apparatus **200** to another disc in the rotor. The forward facing side **216** of the interstage coupling is also an aft surface **216** of the groove **233**. The forward edge **216**, which is also the aft surface **216** of the groove **233**, is where the retaining ring **210** engages along with also potentially engaging with the axially extending surface **215**. The groove **233** is defined by a forward surface **213**, a groove floor **214**, and the aft surface **216**. The groove **233** cuts into the axially extending surface **212** of the disc bore **203** such that the groove floor **214** is depressed within the axially extending surface **212** by a distance equal to the length of the forward surface **213** of the groove **233**. Further, the groove **233** is defined by the aft surface **216** which extends radially further than the forward surface **213** as shown.

The forward surface **213** of the groove **233** is configured with a height such that the forward surface **213** prevents the retaining ring from falling, dropping, or walking forward during assembly. Accordingly, one or more embodiments disclosed herein places the groove **233** in an area where it has not been before, particularly, cut into the disc bore **203** geometry rather than extending from the disc web **202**.

FIG. **3** illustrates a schematic cross-sectional view of area B of FIG. **2** including a portion of the disc **201** and cover plate **206** of a gas turbine engine beginning to engage and connect in accordance with one or more embodiments of the present disclosure. The cover plate includes an axial and radial surface for connecting with the retaining ring **310**. The disc **201** includes the disc bore **203** which includes both the groove **333** and an interstage coupling **307**. As shown, the forward surface of the interstage coupling **307** is also the aft surface **316** of the groove **333**. The groove **333** includes the aft surface **316**, a groove floor **314**, and a forward surface **313**. The groove **333** cuts into an axially extending surface **312** of the disc bore **203**. Further, the forward surface extends from the axially extending surface **312** to the groove floor **314** which is shorter than the aft surface **316** which extends from the groove floor **314** up to the axially extending surface **315** of the interstage coupling **307**.

As shown, when the retaining ring **310** is assembled it engages to connect the disc **201** and cover plate **206**, the retaining ring **310** engages with the axial and aft surfaces of the cover plate **206**. The retaining ring **310** also engages with the aft surface **316** of the groove **333**. This initial engagement limits and controls the forward and aft movement of the cover plate **206** and disc **201**.

FIG. **4**A illustrates a schematic cross-sectional view of a portion of a first disc **401** and a second disc **455** of a gas turbine engine connected using an interstage coupling in accordance with one or more embodiments of the present disclosure. Particularly, as shown the interstage coupling **407** is engaged with an interstage coupling of the second disc **455** such that an aft surface **418** and axial surface **419** of the interstage coupling **407** are engaged with a forward surface **418** and axially extending surface **419** of the second disc **455**.

Further, the interstage coupling **407** also includes a cover plate connector, or groove, on a forward side such that the interstage coupling **407** is configured to also connect and engage with a cover plate **406**. The groove includes an aft surface **416** which is also the forward surface of the interstage coupling **407**. Further, the groove includes a groove floor **414** and a forward surface **413** than cuts into an axially extending surface **412** of a disc bore **403**. The groove is configured to engage and connected with a retaining ring and cover plate **406**. Accordingly, rather than providing separate elements, the interstage coupling **407** can function as both the groove/plate connector and an interstage coupling **407** with another disc **455** as shown.

FIG. **4**B illustrates a schematic cross-sectional view of a portion of another first disc and a second disc of a gas turbine engine connected using another interstage coupling in accordance with one or more embodiments of the present disclosure. As shown, the interstage coupling between the first disc and second disc may additionally include a second retention ring **460** to prevent interstage decoupling. As shown the other element are substantially similar in location with those shown in FIG. **4**A. For example the interchange coupler surfaces **418** and **419** engage with similar surfaces of the second disc as those shown in FIG. **4**A. However, as shown in this embodiment of FIG. **4**B, the shape of the different elements are slightly varied. Further, according to another embodiment as shown, the second disc may have a forward provided retaining ring **450** configured to connect other elements with the second disc. The second disc also includes a second groove **455** that has a forward surface **453** that is also the aft surface of the second interstage coupling. The groove **455** also includes a groove floor **454** and an aft surface **456**. The groove floor **454** is cut into the surface of the second disc a distance equal to the length of the aft surface **456**. As shown, the groove **455** is configured to engage and connect with the retaining ring **450**.

FIG. **5**A illustrates a schematic cross-sectional view of a portion of a disc **501** of a gas turbine engine that includes a scallop **520** in accordance with one or more embodiments of the present disclosure. As shown a retaining ring **510** is engaged and connecting a cover plate **506** with the disc **501**. The scallop **520** is cut into the aft surface **516** of the groove **533**. Accordingly, the scallop **520** provides a flow path for fluid or gas to pass through as indicated by flow line **517**.

FIG. **5**B illustrates a schematic cross-sectional view of a portion of a disc **501** of a gas turbine engine that includes a scallop **521** in accordance with one or more embodiments of the present disclosure. As shown a retaining ring **510** is engaged and connecting a cover plate **506** with the disc **501**. The scallop **521** is cut into all three surfaces of the groove **533**. Specifically, as shown the scallop **521** cuts along the forward surface, **513**, the groove floor **514**, and the aft surface **516**. Accordingly, the scallop **521** provides a flow path for fluid or gas to pass through even in the event that the retaining ring **510** is lower and compressed into the groove **533** cavity.

FIG. **6** illustrates a schematic cross-sectional view of a cover plate **660** of a gas turbine engine that is connected to a disc apparatus **600** in accordance with one or more embodiments of the present disclosure. As shown, a disc **601** is provided which is part of a rotor that can be included within any of the rotors in a gas turbine engine as shown in FIG. **1**. The disc **601** includes at least three components, and may include various surface components. For example, in accordance with one or more embodiments and as shown in FIG. **6**, the disc **601** includes a disc web **602** forming a middle portion of the disc **601** radially extending between a disc bore **603** and a blade attachment **604**.

The disc blade attachment **604** which is attached to an outer diameter of the disc web **602** as shown. That is, the disc blade attachment **604** is connected to an outermost axially extending surface the disc web **602** and extends radially outward from the disc web **602**. An airfoil **622**, which may be for example a blade, connects and extends radially outward from the disc blade attachment. The disc bore **603** is the portion of the disc **601** that is nearest the rotational axis A of the gas turbine engine (e.g., as shown in FIG. **1**). As shown, the disc bore **603** is wider, in the axial direction, than both the disc web **602** and the disc blade attachment **604**. Accordingly, there are provided an axially extending surface **612** at the peripheral ends **605** of the disc bore **603** which the disc web's **602** sides curve and terminate into.

On an aft facing side of the disc **601**, a cover plate **660** may be configured and installed to extend from the disc blade attachment **604** to a portion of the disc bore **603**, as discussed below. The cover plate **660** may form an interference fit or other engagement with the disc blade attachment **604** at an outer diameter thereof and form a connection with a plate connector **633** of the disc **601**, as described below.

Alternatively, a cover plate **606** may be configured and installed on a forward facing side of the disc **601** to extend from the disc blade attachment **604** to a portion of the disc bore **603**.

According to an embodiment, a cover plate is provided that uses two radial snaps to transfer load into the disc and has a feature to enable the use of a z-ring (retaining ring) to keep it axially attached to the disc. Additionally, the retaining ring is located in the bore region of the disc.

For example, looking within area C as shown in FIG. **6**, in accordance with one or more embodiments, the cover plate **660** includes an inner surface that faces in a forward direction toward the disc **601** and an outer surface that faces away from the disc **601** in an aft direction. The cover plate **660** extends radially from the groove **633** at the disc bore **603** radially upward along an outside surface of the disc creating a cavity between the cover plate **660** and disc **601**. The cover plate **660** includes two snaps, a first snap **662** and a second snap **663** that are configured to connect to the disc web **602**. Specifically, the first snap **662** extends axially in a forward direction through the cavity formed between the disc **601** and cover plate **660** far enough to connect with a surface of the disc web **602**. Similarly, the second snap **663** extends axially in the forward direction through the cavity far enough to connect with a surface of the disc web **602**. The first snap **662** can also be called an inner snap **662** because it is located radially inward along the body of the cover plate **660** as compared to the second snap **663** which can be call the outer snap **663** because it is located radially further out along the body of the cover plate **660**.

The cover plate **660** also extends radially inward to form an attachment protrusion **661** for a retaining ring **610** that secures the cover plate **660** to the disc **601** at the disc bore **603**. The attachment protrusion **661** maintains a similar axial thickness as the other regions **664** and **665** of the cover plate **660**. According to another embodiment, the attachment protrusion **661** may also be a full ring member **661** formed to connect with the retention ring **610**. A full ring member **661** can provide structural benefits.

Further, the cover plate **660** includes radially staggered knife edges **666** and **667**. The first knife edge **666** is formed at the top of a protrusion that extends axially in an aft direction and then radially outward. The second knife edge **667** extends from its own protrusion that also extends axially in the aft direction and then radially outward. According to an embodiment, the radially staggered knife edges **666**, **667** are in close proximity to second snap **663**, which can also be called the outer snap **663**, in order to restrain deflections.

Additionally, according to another embodiment, a puller protrusion **668** can be formed at the tip of the attachment protrusion **661**. The puller protrusion extends radially outward from the tip of the attachment protrusion **661** of the cover plate **660**. The puller protrusion may be used to help pull the cover plate **660** away from being engaged with the disc **601**.

Further, according to another embodiment, the cover plate **660** can be formed of two substantially straight angled portions **664**, **665** that extend radially to form the body of the cover plate **660**. This cover plate **660** shape, which includes two substantially straight angled portions **664**, **665**, may help restrain deflections. Additionally, according to another embodiment, the cover plate **660** can reduce stress and better transfer load to the disc.

According to one or more embodiments, the disc also includes a retaining ring **610** that is configured to retain the cover plate **660** in place with respect to the disc **601** when engaged into a groove **614** of a plate connector **633**, which may also be called a groove **633**. In accordance with some embodiments, the retaining ring **610** can be a Z ring, as known in the art. For example, a Z ring is a retaining ring that is substantially z shaped in cross section. The retaining ring **610** is provided along the axially extending surface **612** where the groove **633** meets the interstage coupling **607**. As shown the cover plate **660** extends radially to cover the disc web **602**, or a portion thereof, with two snaps **662** and **663** that connect to the disc web **602**. The cover plate **660** also engages the retaining ring **610** that engaged the plate connector **633**, or groove, on the disc bore **603**.

According to one or more embodiments, the interstage coupling **607**, which is part of and extends from the disc bore **603**, includes a forward facing side **616**. The interstage coupling **607** also includes a protrusion extending from the forward edge **616** in the aft direction a length of an axially extending surface **615** and is configured to connect the disc apparatus **600** to another disc in the rotor. The forward facing side **616** of the interstage coupling is also an aft surface **616** of the groove **633**. The forward edge **616**, which is also the aft surface **616** of the groove **633**, is where the retaining ring **610** engages along with also potentially engaging with the axially extending surface **615**. The groove **633** is defined by a forward surface **613**, a groove floor **614**, and the aft surface **616**. The groove **633** cuts into the axially extending surface **612** of the disc bore **603** such that the groove floor **614** is depressed within the axially extending surface **612** by a distance equal to the length of the forward surface **613** of the groove **633**. Further, the groove **633** is defined by the aft surface **616** which extends radially further than the forward surface **613** as shown.

The forward surface **613** of the groove **633** is configured with a height such that the forward surface **613** prevents the retaining ring from dropping or walking forward during assembly. Accordingly, one or more embodiments disclosed herein places the groove **633** in an area where it has not been before, particularly, cut into the disc bore **603** geometry rather than extending from the disc web **602**.

Thus, in accordance with one or more embodiments, the retaining ring, which may be a Z-Ring, and groove, once provided as disclosed above, can help remove features from the surfaces of the cover plate and the disc web which can reduce the number of life limiting area on the components, or can help free up space previously used by the retaining portion for other features and elements as discussed in one or more embodiments herein.

While the present disclosure has been described in detail in connection with only a limited number of embodiments, it should be readily understood that the present disclosure is not limited to such disclosed embodiments. Rather, the present disclosure can be modified to incorporate any number of variations, alterations, substitutions or equivalent arrangements not heretofore described, but which are commensurate with the scope of the present disclosure. Additionally, while various embodiments of the present disclosure have been described, it is to be understood that aspects of the present disclosure may include only some of the described embodiments. Accordingly, the present disclosure is not to be seen as limited by the foregoing description, but is only limited by the scope of the appended claims.

What is claimed is:

1. A disc for a gas turbine engine, the disc comprising:

a disc web extending in a radial direction relative to an axis of rotation for the gas turbine engine;

a disc bore integral to a radial bottom portion of the disc web, the disc bore comprising;

an axially extending surface at a radial upper portion of the disc bore, the axially extending surface extending axially in a first direction from the disc web, the first direction being one of an aft direction and a forward direction relative to the axis of rotation for the gas turbine engine;

the axially extending surface including a groove formed thereon, wherein the groove includes:

a depth in a radial direction that extends radially into the disc bore, the groove defined by a first axial surface, a groove floor, and a second axial surface, wherein:

the first axial surface extends radially into the disc bore from the first axially extending surface of the disc bore to the groove floor; and

the groove floor extends axially in the first direction to the second axial surface; and

the second axial surface is longer than the first axial surface so that the second axial surface extends radially outward to a radial location that is above the axially extending surface of the disc bore; and

a scallop formed along at least a portion of the second axial surface of the groove, the scallop defining a first scallop surface that extends in the radial direction and is axially offset in the first direction from the second axial surface of the groove, wherein when a retaining ring is positioned against the second axial surface of the groove, the scallop is configured to provide a flow path between the retaining ring and the scallop aft surface.

2. The disc of claim **1**, wherein the disc bore further comprises:

an interstage coupling disposed on the axially extending surface at a peripheral aft edge of the disc bore that includes a protrusion that extends axially in the aft direction beyond an aft surface of the disc bore.

3. The disc of claim **1**, wherein the scallop is formed along the second axial surface extending radially for a length of the second axial surface forming the flow path.

4. The disc of claim **1**, wherein the scallop is formed along the second axial surface and the first axial surface forming the flow path.

5. The disc of claim **1**, further comprising:

a disc blade attachment connected to the disc web at an end of the disc web opposite the disc bore, wherein the disc blade attachment extends radially outward,

wherein the disk blade attachment in configured to attach an airfoil to an upper surface of the disc blade attachment; and

a cover plate that extends from the disc blade attachment radially along an outside surface of the disc web toward the disc bore creating a cavity between the cover plate and disc web.

6. The disc of claim **5**, further comprising:

a retaining ring configured to engage with the groove between the cover plate and disc, wherein the retaining ring connects to an interstage coupling of the disc bore and extends into the groove.

7. The disc of claim **6**, wherein the retaining ring expands into the depth when a compressing force is applied between the cover plate and disc.

8. The disc of claim **1**, wherein an interstage coupling is configured to couple the disc to a second adjacent disc.

9. The disc of claim **1**, wherein the groove is located adjacent to an interstage coupling.

10. The disc of claim **1**, wherein a cover plate and disc hold the retaining ring in place, and wherein the cover plate and disc hold positions relative to each other when connected using the retaining ring.

11. A rotor for a gas turbine engine, the rotor comprising:

at least one disc, the disc comprising:

a disc web extending in a radial direction relative to an axis of rotation for the gas turbine engine,

a disc bore integral to a radial bottom portion of the disc web, the disc bore comprising;

an axially extending surface at a radial upper portion of the disc bore, the axially extending surface extending axially in a first direction from the disc web, the first direction being one of an aft direction and a forward direction relative to the axis of rotation for the gas turbine engine;

the axially extending surface including a groove formed thereon, wherein the groove includes:

a depth in a radial direction that extends radially into the disc bore, the groove defined by a first axial surface, a groove floor, and a second axial surface, wherein:

the first axial surface extends radially into the disc bore from the first axially extending surface of the disc bore to the groove floor;

the groove floor extends axially in the first direction to the second axial surface; and

the second axial surface is longer than the first axial surface so that the second axial surface extends radially outward to a radial location that is above the axially extending surface of the disc bore; and

a scallop formed along at least a portion of the second axial surface of the groove, the scallop defining a first scallop surface that extends in the radial direction and is axially offset in the first direction from the second axial surface of the groove, wherein when a retaining ring is positioned against the second axial surface of the groove, the scallop is configured to provide a flow path between the retaining ring and the scallop aft surface;

a disc blade attachment connected to the disc web at an end of the disc web opposite the disc bore, wherein the disc blade attachment extends radially outward;

a cover plate that extends from the disc blade attachment radially along an outside surface of the disc web toward disc bore creating a cavity between the cover plate and disc web;

a retaining ring configured to engage with the groove between the cover plate and disc; and

an airfoil extending radially outward and connected to an upper surface of the disc blade attachment of the disc.

12. The rotor of claim **11**, wherein the scallop is formed along the second axial surface extending radially for a length of the second axial surface forming the flow path.

13. The rotor of claim **11**, wherein the scallop is formed along the second axial surface and the first axial surface forming the flow path.

14. The rotor of claim **11**, further comprising a plurality of discs, a plurality of disc blade attachments, a plurality of cover plates, a plurality of retaining rings, and a plurality of airfoils.

15. The rotor of claim **11**, wherein the rotor is one selected from a group consisting of a compressor rotor, a combustor rotor, and a turbine rotor.

16. The rotor of claim **11**, wherein the retaining ring connects to the interstage coupling of the disc bore and extends into the groove.

17. The rotor of claim **11**, wherein the retaining ring expands into the depth when a compressing force is applied between the cover plate and disc.

18. The rotor of claim **11**, wherein the interstage coupling is configured to couple the disc to a second adjacent disc.

19. The rotor of claim **11**, wherein the groove is located adjacent to the interstage coupling.

20. A gas turbine engine comprising:

a turbine section;

a combustor section to provide combustion gases to the turbine section; and

a compressor section to compress an airflow and direct the compressed airflow toward the combustor; and

a rotor disposed in at least one of the turbine section, combustor section, and compressor section, the rotor comprising:

at least one disc, the disc comprising:

a disc web extending in a radial direction relative to an axis of rotation for the gas turbine engine;

a disc bore integral to a radial bottom portion of the disc web, the disc bore comprising;

an axially extending surface at a radial upper portion of the disc bore, the axially extending surface extending axially in a first direction from the disc web, the first direction being one of an aft direction and a forward direction relative to the axis of rotation for the gas turbine engine;

the axially extending surface including a groove formed thereon, wherein the groove includes:

a depth in a radial direction that extends radially into the disc bore, the groove defined by a first axial surface, a groove floor, and a second axial surface, wherein:

the first axial surface extends radially into the disc bore from the first axially extending surface of the disc bore to the groove floor;

the groove floor extends axially in the first direction to the second axial surface; and

the second axial surface is longer than the first axial surface so that the second axial surface extends radially outward to a radial location that is above the axially extending surface of the disc bore; and

a scallop formed along at least a portion of the second axial surface of the groove, the scallop defining a first scallop surface that extends in the radial direction and is axially offset in the first direction from the second axial surface of the groove, wherein when a retaining ring is positioned against the second axial surface of the groove, the scallop is configured to provide a flow path between the retaining ring and the scallop aft surface;

an interstage coupling disposed on the axially extending surface at a peripheral aft edge of the disc bore that includes a protrusion that extends axially in the aft direction beyond an aft surface of the disc bore;

a disc blade attachment connected to the disc web at an end of the disc web opposite the disc bore, wherein the disc blade attachment extends radially outward;

a cover plate that extends from the disc blade attachment radially along an outside surface of the disc web toward disc bore creating a cavity between the cover plate and disc web;

a retaining ring configured to engage with the groove between the cover plate and disc; and

an airfoil extending radially outward and connected to an upper surface of the disc blade attachment of the disc.

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